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SHORT COMMUNICATION

Wild pistachio tree (*Pistacia mutica*) in the Qalajeh forest region of western Iran

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Abstract: Wild pistachio tree（*Pistacia mutica*）is considered the most important species in the Zagros forests. It can adapt to unfavorable environmental conditions. To find the suitable ecological conditions for pistachio species, we investigated different environmental factors such as gradient, aspect and position of the slopes through the distribution area. Frequency of pistachio trees in the north and northwest of Qalajeh forests was 36.4% and 1%, respectively. Maximum (32%) and minimum (13%) number of wild pistachio trees were in 30%–60% and >120% slope classes, respectively. The most number and least number of pistachio trees were found at elevations of 1100–1200 m and 2200–2300 m, respectively. The percentage of pistachio canopy coverage was 10. The average percentage of herbaceous coverage was 6.5. Pistachio trees of diameter per hectare at breast height (DBH) >20 cm numbered 5 while average number of pistachio trees was 8 per hectare. Pistachio seedlings per hectare averaged 3.5. The number of other species per ha was 7 trees. The effect of aspect on other species was not significant (p=0.151). Slope class and geographical aspect did not affect regeneration (p=0.275 and p=0.111, respectively). Pistachio plays an important economic role in semi-arid areas, therefore it is essential to protect and restore Qalajeh forests through participation by government and local people.

Keywords: quantitative investigation; quality; coverage percentage; Qalajeh habitat; *Pistacia mutica*

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Introduction

The Zagros forest ecosystem is composed of a mixture of deciduous trees and tropical evergreen trees or shrubs. It is important for forest managers to quantify and qualify of forest vegetation (Bordbar et al. 2001).

Semi-arid forests at Zagros play a critical role in regulating climate, conserving soil, affecting vegetation cover, and other ecological functions in west Iran. Zagros forests have expanded nearly 1300 km along the Zagros range from the south of Azerbaijan to Fars Province (Marvie Mohadjer 2012). Rainfall fluctuates from 600 mm in the north to 300 mm in the southwest of this region. The climate is semi-arid Mediterranean with cold winters (Marvie Mohadjer 2012). Other than *Pistachio mutica*, tree species in this forest include Persian oak (*Quercus brantii*), Lusitanian oak (*Quercus infectoria*), Lebanon oak (*Quercus libani*), Maple (*Acer cappadocicum*), Pistachio (*Pistacia atlantica*), Ash (*Fraxinus rotundifolia*), Wild pear (*Pyrus glabra*), Hawthorn (*Crataegus aronia*), Purple (*Cercis griffithii*) and various Almonds (*amygdalus sp*) (Marvie Mohadjer 2012). Pistachio (*Pistacia mutica* F. &. M) of the pistachio family (*Anacardiaceae*) is deciduous tree growing to heights of up to 15 m (Sabeti 2006). Other forest trees and shrubs in Qalajeh region include *Q. brantii*, *Prunus spinosa*, *Ficus carica*, *Ulmus carpinifolia*, *amygdalus* sp., *F. rotundifolia* and *C. aronia*. Pistachio species are pure forest or sometimes companion with other species in the region (Pourreza et al. 2008).

Wild pistachio (*P. mutica*) is the only species of the Pistachio genus in the Mediterranean region and is expanding in northern Africa arid and semi-arid regions (Gourine et al. 2010). *P. mutica* grows in association with other species, including *Amygdalus scoparia*, *Quercus persica*, and *Acer monspessolanum* at various elevation in the Zagros vegetation region. Wild pistachio occurs as an associate species at 1000–2000 m elevation in pure oak stands (Jazireii et al. 2003; Marvie Mohadjer 2012). *P. mutica* is

not observed from sea level to 700 m a.s.l. or above 2500 m a.s.l.. In other climate and altitudinal areas, pistachio is expanding as a dominant species (Salehi et al. 2001). Pistachio tree is considered one of the most important trees species in Zagros due to its compatibility with the local environment as well as its economic value for gum production (Khodakarami et al. 2006). Pistachio is valuable for soil conservation and is also suitable for plantation in arid lands. Pistachio regeneration is difficult, however, in western Iran due to degradation of natural habitats (Hosseini et al. 2007).

Pistachio species will be threatened in Kermanshah Province in future because of low seedling survival (Walter 1983Pistachio grows best on northerly aspects where soils are more moist and richer, although it also grows on other slope aspects (Jazireii et al. 2003). Pourreza et al. (2008) confirmed that Pistachio trees decreased less than 30 cm at diameter classes in the Qalajeh forests. Trees with diameter at breast height (DBH) ≥ 30 cm were very closely by De liocourt coefficient for diameter distribution (r^2 = 0.93). De liocourt coefficient is 1.3–1.5 in natural forest (Marvie Mohadjer 2012).

Species of wild pistachio in Yazd Province were found mainly on rocky lands in central Iran (Rad et al. 2001). Our main objective in this research was to compile data on required ecological conditions for establishing pistachio species in Qalajeh habitats.

Materials and methods

Our study area was located in northwestern Zagros in Kermanshah Province in west Iran, from 49°10′46″ to 13°29′46″ longitude and 11°54′33″ to 51°05′34″ latitude (Fig. 1). Qalajeh forest region has approximately 19000 ha area. Average annual rainfall in the Qalajeh highlands is 516.7 mm and the climate is Mediterranean. Soils are generally silty-clays to clays. In Qalajeh forest, there are three important forest types, including *Quercus persica* (<1500m, a.s.l.), *Q. persica–P. atlantica* (1500–2170 m), and *Amygdalus orientalis* (>2170 m), (Ghazanfari et al. 2004). Wild pistachio in Qalajeh grows slowly with annual diameter increment ranging from 2 to 6 mm (Zangeneh 2003; Zohrehvandi 2003).

We surveyed pistachio species using a systematic inventory method. Dimensions of fixed sampling plots were 400 × 500 m. each plot had 4000 m^2 area. Quantitative and qualitative sampling was conducted at 60 plots. Seedlings were counted in 60 subplots that each of them has covering 400 m^2 area, according to sparseness forest (Zobeiri 2009; Zahedi Pour 2007). We recorded total number of pistachio trees, number of pistachio species by slope class, number of pistachio species by height class, pistachio canopy coverage percentage, percent herbaceous cover, total pistachio trunk diameter for trees >20 cm in height, number of pistachio seedlings, and number of other species.

We recorded topographic data, including slope steepness, slope aspect, and elevation at sampling sites. Five slope classes were defined as 0–30%, 30%–60%, 60%–90%, 90%–120% and >120%.

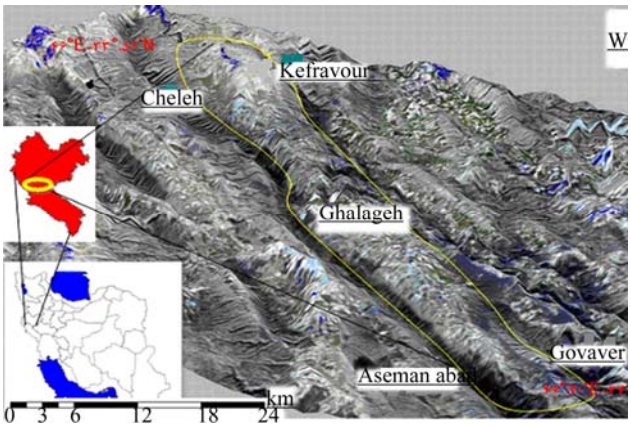

Fig. 1 Location of study area

We also recorded quantitative and qualitative indexes of Qalajeh habitat including total number of trees per hectare, height of trees, minimum and maximum canopy coverage diameter, height of stem, and diameter at breath height.

Results

The frequency of pistachio tree ranged from a high of 36.4% on northerly aspects to 1% on northwest aspects (Fig. 2). Maximum (32%) and minimum (13%) number of wild pistachio trees were recorded on slopes of 30%–60% and >120% respectively (Fig. 3). Maximum (22.45%) and minimum (3%) relative frequencies of pistachio trees were at elevations of 1100–1200 and 2200–2300 m, respectively (Fig. 4). Percent pistachio canopy coverage was 10%, mean percent herbaceous cover was 6.5%, and pistachio trees with DBH >20 cm was 8 per hectare. Average number of pistachio trees was 8 per hectare, pistachio seedlings numbered 3.5 per hectare and number of other species was 7 per hectare (Table 1). There was a significant effect of elevation and slope aspect on pistachio canopy cover, herb cover, total number of pistachio trees, number of pistachio trees of DBH >20 cm, and number of pistachio seedlings (Tables 2, 3, 4).

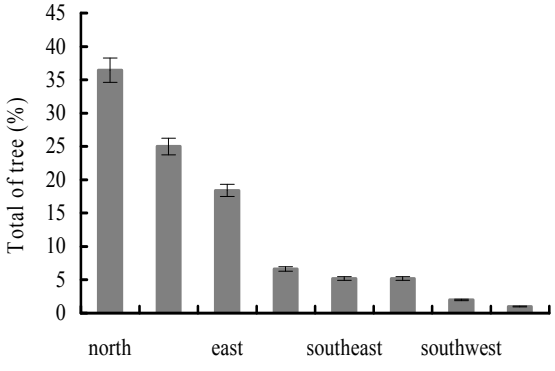

Fig. 2 Distribution of pistachio tree in the geographic direction

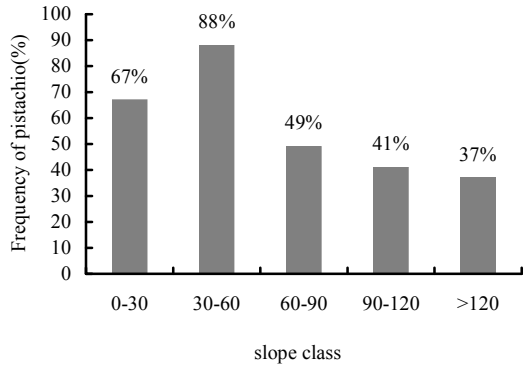

Fig. 3 Frequency of pistachio by slope steepness in different slope class (0–30%, 30%–60%. 60%–90%, 90%–120%, >120%)

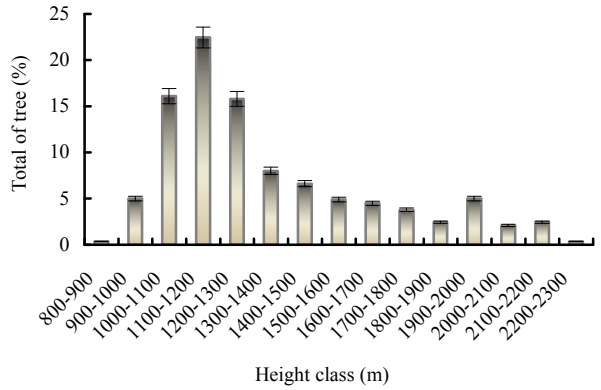

Fig. 4 Frequency distribution of pistachio species by elevation (m, a.s.l.)

Table 1. Ecological characteristics of pistachio species in plots

Row	Mean canopy cover (%)	Mean herb cover (%)	Mean of pistachio	Mean no. of pistachio trees (>20 cm DBH)	Mean no. of pistachio seedlings	Mean no. of other species
3	13.12	13.75	13	9	3	11.5
6	15.3	12.5	2.3	2.25	2	17.2
9	24.4	20.6	12	8	3	23
12	20.3	14.06	11.7	7	2	15.9
15	31	16.25	8	5	2	23.8
18	27.6	13.7	2	0	1	17.9
21	34	16.9	3	2	1	44.8
24	21.4	14.8	11.9	6	5	19.25
27	19.7	10.9	9	4	5	13.37
30	16.9	10.3	2	1	1	16.06
33	11.8	8.5	5	3		0
36	7.4	7.2	10.5	6	0	12
39	7.64	4.7	10	8		0
42	10.12	6	5	4		8.1
45	21.25	14.7	7	5		13.8
48	17.3	13.1	12	2	6	8.8
51	24.2	19	6	7	3	7.6
54	21.7	13.75	6	4	1.2	10.25
57	25	13	5	2	4	2.2
60	28	15	11.3	9	2	6.3
Means (ha)	10	6.5	8	5	3.5	6.8

Table 2. Results of ANOVA for canopy cover, herb cover, pistachio, seedlings and other species by height class

Items	Geographical aspect	df	Mean Square	F	Significant level
Pistachio canopy cover	Between Groups	14	1.114	2.788	0.001*
	Within Groups	299	.399		
	Total	313			
Herbage cover	Between Groups	14	.912	4.560	0.000*
	Within Groups	299	.200		
	Total	313			
Total pistachio	Between Groups	14	11.519	2.407	0.003*
	Within Groups	299	4.786		
	Total	313			
Pistachio with DBH more than 20 cm	Between Groups	14	10.261	2.516	0.002*
	Within Groups	299	4.078		
	Total	313			
Pistachio regeneration	Between Groups	14	92.625	2.754	0.001*
	Within Groups	299	33.631		
	Total	313			
Other species	Between Groups	14	1717.139	1.924	0.024 *
	Within Groups	299	892.291		
	Total	313			

Notes: * stands for significant at 5% level and ns stands for not significant.

Table 3. Results of ANOVA of canopy cover, herb cover, number of seedlings and other species by slope aspect

Items	Slope aspect	df	Mean Square	F	Significant level
Pistachio canopy cover	Between Groups	8	1.214	2.955	0.003*
	Within Groups	305	0.411		
	Total	313			
Herbage cover	Between Groups	8	0.724	3.307	0.001*
	Within Groups	305	0.219		
	Total	313			
Total pistachio	Between Groups	8	25.384	5.573	0.000*
	Within Groups	305	4.555		
	Total	313			
Pistachio with DBH more than 20 cm	Between Groups	8	22.860	5.908	.000*
	Within Groups	305	3.870		
	Total	313			
Pistachio regeneration	Between Groups	8	44.735	1.241	.275 ns
	Within Groups	305	36.048		
	Total	313			
Other species	Between Groups	8	2097.974	2.335	0.019 *
	Within Groups	305	898.529		
	Total	313			

Notes: * stands for significant at 5% level and ns stands for not significant.

Table 4. Results of ANOVA about canopy cover, herbage cover, pistachio, regeneration and other species in slope class

Items	Geographical aspect	d*f*	Mean Square	*F*	Significant level
Pistachio canopy cover	Between Groups	5	2.941	7.528	0.000*
	Within Groups	308	0.391		
	Total	313			
Herbage cover	Between Groups	5	0.912	4.129	0.001*
	Within Groups	308	.221		
	Total	313			
Total pistachio	Between Groups	5	83.725	21.970	0.000*
	Within Groups	308	3.811		
	Total	313			
pistachio with DBH more than 20 cm	Between Groups	5	68.456	20.654	0.000*
	Within Groups	308	3.314		
	Total	313			
Pistachio regeneration	Between Groups	5	64.738	1.808	0.111 ns
	Within Groups	308	35.807		
	Total	313			
Other species	Between Groups	5	1503.637	1.635	.151 ns
	Within Groups	308	919.860		
	Total	313			

Notes: * stands for significant at 5% level and ns stands for not significant.

Discussion

Wild pistachio tree species mainly exist in the Qalajeh habitat. Trees in this habitat were coppiced by livestock grazing. The highest relative frequency of whole pistachio trees on north-facing slopes was possibly due to higher soil moisture there. The 25% of pistachio trees have been established in the South. Thus we can say that the main factor of establishing pistachio tree is soil moisture and moisture in the air. Pistachio species in the southern directions are more than other species because pistachio is a typical plant of sunny habitats. It is justified that light and humidity for the pistachio establishment are more favorable factors in the south directions (Rad et al. 2001; Jazireii et al. 2003; Gourine et al. 2010). Generally, northern direction is more humid than the southern in the Northern Hemisphere (Walter, 1983)

Maximum relative frequency (32%) of total pistachio trees was recorded on slopes of 30%–60%. Minimum relative frequency (13%) was recorded on slopes >120%. Slopes of 30%–60% provided optimum conditions in terms of slope steepness. Pistachio canopy coverage was approximately 10% in Qalajeh forests. Traditionally the study area was grazed by livestock in the spring and valuable pistachio trees were damaged by grazing each year.

Herbaceous plants on the forest floor are typically found under gaps in the canopy where light intensity is high (Marvie Mohadjer 2012). Zagros forests are generally thin with gaps in the canopy. The understory consisted of grasses and flowering plants due to availability of light and space. Growth of the understory was most lush in the spring. In this research, herbaceous coverage percentage was 6.5%, because of synchronization of data collection (in summer) with the annual gum production season. Total numbers of pistachio trees is reduced in Qalajeh forests because local people and nomadic tribes harvest pistachio trees to exploit their economic value. Exploitation causes severe damage to the pistachio trees (Khodakarami et al. 2001).

Natural regeneration of forest tree species is considered a vital process to maintain populations and species richness. Non-biotic factors (light, water, and soil nutrients) and biotic factors (competition and grazing) affect natural regeneration of tree species. Qalajeh is semiarid and has suitable light and soil moisture conditions for growth of pistachio trees. However, excessive livestock grazing in Qalajeh, has caused severe soil erosion. The bedrock emerged in many areas, causing increased flood erosion risk. Pistachio fruits are harvested by local exploiters in autumn. So only the poorest quality seeds are left for natural regeneration.

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